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CONTENTS

A Mechanistic View of Psychology: DR. GEORGE W. CRILE 283

The Chestnut-blight Parasite (Endothia parasitica) from China: DR. C. L. SHEAR, NEIL E. STEVENS 295

The Discovery of the Chestnut Bark Disease in China: DR. DAVID FAIRCHILD 297

Scientific Notes and News 299

University and Educational News 301

Discussion and Correspondence:—
Color Correlation in Cowpeas: DR. W. J. SPILLMAN. *Variations in the Earth's Magnetic Field:* PROFESSOR FRANCIS E. NIPHER. *Excusing Class Absences in College:* DR. E. A. MILLER 302

Scientific Books:—
Pycraft's The Infancy of Animals: PROFESSOR FRANCIS H. HERRICK. *Brunswig on Explosives:* DR. A. P. SY 304

Notes on Meteorology and Climatology:—
The Solar Constant of Radiation; West India Hurricanes; Humidity and Frost Damage; Australian Meteorology; Notes: CHARLES F. BROOKS 309

Special Articles:—
The Rediscovery of Peridermium pyriforme Peck: PROFESSOR J. C. ARTHUR, DR. FRANK D. KERN. *A Wine-red Sunflower:* PROFESSOR T. D. A. COCKERELL 311

Societies and Academies:—
The Biological Society of Washington: M. W. LYON, JR. 313

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

A MECHANISTIC VIEW OF PSYCHOLOGY[1]

TRADITIONAL religion, traditional medicine and traditional psychology have insisted upon the existence in man of a triune nature. Three "ologies" have been developed for the study of each nature as a separate entity—body, soul and spirit; physiology, psychology, theology; physician, psychologist, priest. To the great minds of each class, from the days of Aristotle and Hippocrates on, there have come glimmerings of the truth that the phenomena studied under these divisions were interrelated. Always, however, the conflict between the votaries of these sciences has been sharp, and the boundary lines between them have been constantly changing. Since the great discoveries of Darwin, the zoologist, biologist and physiologist have joined hands, but still the soul-body-spirit chaos has remained. The physician has endeavored to fight the gross maladies which have been the result of disordered conduct; the psychologist has reasoned and experimented to find the laws governing conduct; and the priest has endeavored by appeals to an unknown god to reform conduct.

The great impulse to a deeper and keener study of man's relation, not only to man, but to the whole animal creation, which was given by Darwin, has opened the way to the study of man on a different basis. Psychologists, physicians and priests are now joining hands as never before in the great world-wide movement for the betterment of man. The new sci-

[1] Paper read before Sigma Xi, Case School of Science, Cleveland, Ohio, May 27, 1913.

ence of sociology is combining the functions of all three, for priest, physician and psychologist have come to see that man is in large measure the product of his environment.

My thesis to-night, however, will go beyond this common agreement, for I shall maintain, not that man is in *large measure* the product of his environment, but that environment has been the actual *creator* of man; that the old division between body, soul and spirit is non-existent; that man is a unified mechanism responding in every part to the adequate stimuli given it from without by the environment of the present and from within by the environment of the past, the record of which is stored in part in cells throughout the mechanism, but especially in its central battery—the brain. I postulate further that the human body mechanism is equipped first for such conflict with environment as will tend to the preservation of the individual and second for the propagation of the species, both of these functions when most efficiently carried out tending to the upbuilding and perfection of the race.

Through the long ages of evolution the human mechanism has been slowly developed by the constant changes and growth of its parts which have resulted from its continual adaptation to its environment. In some animals the protection from too rough contact with surroundings was secured by the development of an outside armor; in others noxious secretions served the purposes of defense, but such devices as these were not suitable for the higher animals or for the diverse and important functions of the human race. The safety of the higher animals and of man had to be preserved by some mechanism by means of which they could become adapted to a much wider and more complex environment, the dominance over which alone gives them their right to be called "superior beings." The mechanism by the progressive development of which living beings have been able to react more and more effectually to their environment is the central nervous system, which is seen in one of its simplest forms in motor plants, such as the sensitive plant and the Venus fly trap, and in its highest development only in the sanest, healthiest, happiest and most useful men.

The essential function of the nervous system was primarily to secure some form of motor activity, first as a means of securing food, and later as a means of escaping from enemies and to promote procreation. Activities for the preservation of the individual and of the species were and are the only purposes for which the body energy is expended. The central nervous system has accordingly been developed for the purpose of securing such motor activities as will best adapt the individuals of a species for their self-preservative conflict with environment.

It is easy to appreciate that the simplest expressions of nerve response—the reflexes—are motor in character, but it is difficult to understand how such intangible reactions as love, hate, poetic fancy, or moral inhibition can be also the result of the adaptation to environment of a distinctively motor mechanism. We expect, however, to prove that so-called "psychic" states as well as the reflexes are products of adaptation; that they occur automatically in response to adequate stimuli in the environment; that like the reflexes they are expressions of motor activity, which, although intangible and unseen, in turn incites to activity the units of the motor mechanism of the body; and finally, that any "psychic" condition results in a definite depletion of the potential energy in the brain cells which is proportionate to

the muscular exertion of which it is the representative.

That this nerve mechanism may effectively carry out its twofold function, first, of self-adaptation to meet adequately the increasingly complicated stimuli of environment; and second, of in turn adapting the motor mechanism to respond adequately to its demands, there have been implanted in the body numerous nerve ceptors—some for the transmission of stimuli harmful to the mechanism—nociceptors; some of a beneficial character—beneceptors; and still others more highly specialized, which partake of the nature of both bene- and nociceptors—the distance ceptors, or special senses.

A convincing proof that environment has been the creator of man is seen in the absolute adaptation of the nociceptors as manifested in their specific response to adequate stimuli, and in their presence in those parts of the body only which throughout the history of the race have been most exposed to harmful contacts. We find they are most numerous in the face, the neck, the abdomen, the hands and the feet; while in the back they are few in number, and within the bony cavities they are lacking.

Instances of the specific responses made by the nociceptors might be multiplied indefinitely. Sneezing, for example, is a specific response made by the motor mechanism to stimulation of the nociceptors in the nose, while stimulation of the larynx does not produce a sneeze, but a cough; stimulation of the nociceptors of the stomach does not produce cough, but vomiting; stimulation of the nociceptors of the intestine does not produce vomiting, but increased peristaltic action. There are no nociceptors misplaced; none wasted; none that do not make an adequate response to adequate stimulation.

Another most significant proof that the environment of the past has been the creator of the man of to-day is seen in the fact that man has added to his environment certain factors to which adaptation has not as yet been made. For example, heat is a stimulus which has existed since the days of prehistoric man, while the X-ray is a discovery of to-day; to heat the nociceptors produce an adequate response; to the X-ray there is no response. There was no weapon in the prehistoric ages which could move at the speed of a bullet from the modern rifle; therefore, while slow penetration of the tissues produces great pain and muscular response, there is no response to the swiftly moving bullet.

The response to contact stimuli then depends always on the presence of nociceptors in the affected part of the body and to the type of the contact. Powerful response is made to crushing injury by environmental forces; to such injuring contacts as resemble the impacts of fighting; to such tearing injuries as resemble those made by teeth and claws. On the other hand, the sharp division of tissue by cutting produces no adaptive response; indeed, one might imagine that the body could be cut to pieces by a superlatively sharp knife applied at tremendous speed without material adaptive response.

These examples indicate how the history of the phylogenetic experiences of the human race may be learned by a study of the position and the action of the nociceptors just as truly as the study of the arrangement and variations in the strata of the earth's crust discloses to us geologic history.

These adaptive responses to stimuli are the result of the action of the brain cells which are thus continually played upon by the stimuli of environment. The energy stored in the brain cells in turn activates the various organs and parts of the body.

If the environmental impacts are repeated with such frequency that the brain cells have no time for restoration between them, the energy of the cells becomes exhausted and a condition of shock results. Every action of the body may thus be analyzed into a stimulation of ceptors, a consequent discharge of brain cell energy, and a final adaptive activation of the appropriate part. Walking, running and their modifications constitute an adaptation of wonderful perfection, for, as Sherrington has shown, the adaptation of locomotion consists of a series of reflexes—ceptors in the joints, in the limb and in the foot being stimulated by variations in pressure.

As we have shown, the bene- and nociceptors orientate man to all forms of physical contact—the former *guide him to* the acquisition of food and to sexual contact; the latter *direct him from* contacts of a harmful nature. The distance ceptors, on the other hand, adapt man to his distant environment by means of communication through unseen forces—ethereal vibrations produce sight; air waves produce sound; microscopical particles of matter produce smell. The advantage of the distance ceptors is that they allow time for orientation, and because of this great advantage the majority of man's actions are responses to their adequate stimuli. As Sherrington has stated, the greater part of the brain has been developed by means of stimuli received through the special senses, especially through the light ceptors, the optic nerves.

We have just stated that by means of the distance ceptors animals and man orientate themselves to their distant environment. As a result of the stimulation of the special senses chase and escape are effected, fight is conducted, food is secured, and mates are found. It is obvious, therefore, that the distance ceptors are the primary cause of continuous and exhausting expenditures of energy. On the other hand, stimuli applied to contact ceptors lead to short, quick discharges of nervous energy. The child puts his hand in the fire and there is an immediate and complete response to the injuring contact; he sees a pot of jam on the pantry shelf and a long train of continued activities are set in motion, leading to the acquisition of the desired object.

The contact ceptors do not at all promote the expenditure of energy in the chase or in fight, in the search for food or for mates. Since the distance ceptors control these activities, one would expect to find that they control also those organs whose function is the production of energizing internal secretions. Over these organs—the thyroid, the adrenals, the hypophysis—the contact ceptors have no control. Prolonged laboratory experimentation seems to prove this postulate. According to our observations, no amount of physical trauma inflicted upon animals will cause hyperthyroidism or increased epinephrin in the blood, while fear and rage do produce hyperthyroidism and increased epinephrin. This is a statement of far-reaching importance and is the key to an explanation of many chronic diseases—diseases which are associated with the intense stimulation of the distance ceptors in human relations.

Stimuli of the contact ceptors differ from stimuli of the distance ceptors in still another important particular. The adequacy of stimuli of the contact ceptors depends upon their number and intensity, while the adequacy of the stimuli of the distance ceptors depends upon the *experience* of the species and of the individual. That is, according to phylogeny and ontogeny this or that sound, this or that smell, this or that sight, through associa-

tion recapitulates the experience of the species and of the individual—awakens the phylogenetic and ontogenetic memory. In other words, sights, sounds and odors are symbols which awaken phylogenetic association. If a species has become adapted to make a specific response to a certain object, then that response will occur automatically in an individual of that species when he hears, sees or smells that object. Suppose for example, that the shadow of a hawk falls simultaneously on the eyes of a bird, a rabbit, a cow and a boy. That shadow would at once activate the rabbit and the bird to an endeavor to escape, each in a specific manner according to its phylogenetic adaptation; the cow would be indifferent and neutral; while the boy, according to his personal experience or ontogeny, might remain neutral, might watch the flight of the hawk with interest or might try to shoot it.

Each phylogenetic and each ontogenetic experience develops its own mechanism of adaptation in the brain; and the brain threshold is raised or lowered to stimuli by the strength and frequency of repetition of the experience. Thus through the innumerable symbols supplied by environment the distance ceptors drive this or that animal according to the type of brain pattern and the particular state of threshold which has been developed in that animal by its phylogenetic and ontogenetic experiences. The brain pattern depends upon his phylogeny, the state of threshold upon his ontogeny. Each *brain pattern* is created by some particular element in the environment to which an adaptation has been made for the good of the species. The *state of threshold* depends upon the effect made upon the individual by his personal contacts with that particular element in his environment. The presence of that element produces in the individual an associative recall of the adaptation of his species—that is, the brain pattern developed by his phylogeny becomes energized to make a specific response. The intensity of the response depends upon the state of threshold—that is, upon the associative recall of the individual's own experience—his ontogeny.

If the full history of the species and of the individual could be known in every detail, then every detail of that individual's conduct in health and disease could be predicted. Reaction to environment is the basis of conduct, of moral standards, of manners and conventions, of work and play, of love and hate, of protection and murder, of governing and being governed, in fact, of all the reactions between human beings—of the entire web of life. To quote Sherrington once more: "Environment drives the brain, the brain drives the various organs of the body."

By what means are these adaptations made; what is the mechanism through which adequate responses are made to the stimuli received by the ceptors? We postulate that in the brain there are innumerable patterns each the mechanism for the performance of a single kind of action, and that the brain cells supply the energy—electric or otherwise—by which the act is performed; that the energy stored in the brain cells is in some unknown manner released by the force which activates the brain pattern; and that through an unknown property of these brain patterns each stimulus causes such a change that the next stimulus of the same kind passes with greater facility.

Each separate motor action presumably has its own mechanism—brain pattern—which is activated by but one ceptor and by that ceptor only when physical force of a certain intensity and rate of motion is applied. This is true both of the visible

contacts affecting the nociceptors and of the invisible contacts by those intangible forces which affect the distance ceptors. For example, each variation in speed of the light-producing waves of ether causes a specific reaction in the brain. For one speed of ether waves the reaction is the perception of the color blue; for another, yellow; for another, violet. Changes in the speed of air waves meet with specific response in the brain patterns tuned to receive impressions through the aural nerves, and so we distinguish differences in sound pitch. If we can realize the infinite delicacy of the mechanisms adapted to these infinitesimal variations in the speed and intensity of invisible and intangible stimuli, it will not be difficult to conceive the variations of brain patterns which render possible the specific responses to the coarser contacts of visible environment.

Each brain pattern is adapted for but one type of motion, and so the specific stimuli of the innumerable ceptors play each upon their own brain patterns only. In addition, each brain pattern can react to stimuli applied only within certain limits. Too bright a light blinds; too loud a sound deafens. No mechanism is adapted for waves of light above or below a certain rate of speed, although this range varies in different individuals and in different species according to the training of the individual and the need of the species.

We have already referred to the fact that there is no receptive mechanism adapted to the stimuli from the X-ray, from the high-speed bullet, from electricity. So, too, there are innumerable forces in nature which can excite in man no adaptive response, since there exist in man no brain patterns tuned to their waves, as in the case of certain ethereal and radioactive forces.

On this mechanistic basis the emotions may be explained as activations of the entire motor mechanism for fighting, for escaping, for copulating. The sight of an enemy stimulates in the brain those patterns formed by the previous experiences of the individual with that enemy, and also the experiences of the race whenever an enemy had to be met and overcome. These many brain patterns in turn activate each that part of the body through which lies the path of its own adaptive response—those parts including the special energizing or activating organs. Laboratory experiments show that in an animal driven strongly by emotion the following changes may be seen: (1) a mobilization of the energy-giving compound in the brain cells, evidenced by a primary increase of the Nissl substance and a later disappearance of this substance and the deterioration of the cells; (2) increased output of epinephrin, of thyroid secretion, of glycogen and an increase of the power of oxidation in the muscles; (3) accelerated circulation and respiration with increased body temperature; (4) altered metabolism. All of these are adaptations to increase the motor efficiency of the mechanism. In addition we find an inhibition of the functions of every organ and tissue that consumes energy, but does not contribute directly to motor efficiency. The mouth becomes dry; the gastric and pancreatic secretions are lessened or are completely inhibited; peristaltic action stops. The obvious purpose of all these activations and inhibitions is to mass every atom of energy upon the muscles that are conducting the defense or attack.

So strong is the influence of phylogenetic experience that though an enemy today may not be met by actual physical attack, yet the decks are cleared for action, as it were, and the weapons made ready, the body as a result being shaken and ex-

hausted. The type of emotion is plainly declared by the activation of the muscles which would be used if the appropriate physical action were consummated. In anger the teeth are set, the fists are clenched, the posture is rigid; in fear the muscles collapse, the joints tremble and the running mechanism is activated for flight; in sexual excitement the mimicry is as obvious. The emotions, then, are the preparations for phylogenetic activities. If the activities are consummated, the fuel —glycogen—and the activating secretions from the thyroid, the adrenals, the hypophysis are consumed. In the activation without action, these products must be eliminated as waste products and so a heavy strain is put upon the organs of elimination. It is obvious that the body under emotion might be clarified by active muscular exercise, but the subject of the emotion is so strongly integrated thereby that it is difficult for him to engage in diverting, clarifying exertion. The person in anger does not want to be saved from the ill-effects of his own emotion; he wants only to fight; the person in fear wants only to escape; the person under sexual excitement wants only possession.

All the lesser emotions—worry, jealousy, envy, grief, disappointment, expectation—all these influence the body in this manner, the consequences depending upon the intensity of the emotion and its protraction. Chronic emotional stimulation, therefore, may fatigue or exhaust the brain and may cause cardiovascular disease, indigestion, Graves's disease, diabetes, and insanity even.

The effect of the emotions upon the body mechanism may be compared to that produced upon the mechanism of an automobile if its engines are kept running at full speed while the machine is stationary. The whole machine will be shaken and weakened, the batteries and weakest parts being the first to become impaired and destroyed, the length of usefulness of the automobile being correspondingly limited.

We have shown that the effects upon the bodily mechanism of the action of the various ceptors is in relation to the response made by the *brain* to the stimuli received. What is this power of response on the part of the brain but *consciousness?* If this is so, then consciousness itself is a reaction to environment, and its intensity must vary with the state of the brain and with the environmental stimuli. If the brain cells are in the state of highest efficiency, if their energy has not been drawn upon, then consciousness is at its height; if the brain is fatigued, that is, if the energy stored in the cells has been exhausted to any degree, then the intensity of consciousness is diminished. So degrees of consciousness vary from the height maintained by cells in full vigor through the stages of fatigue to sleep, to the deeper unconsciousness secured by the administration of inhalation anesthetics, to that complete unconsciousness of the environment which is secured by blocking the advent to the brain of all impressions from both distance and contact ceptors, by the use of both local and inhalation anesthetics —the state of anoci-association.

Animals and man may be so exhausted as to be only semi-conscious. While a brain perfectly refreshed by a long sleep can not immediately sleep again, the exhausted brain and the refreshed brain when subjected to equal stimuli will rise to unequal heights of consciousness. The nature of the physical basis of consciousness has been sought in experiments on rabbits which were kept awake from 100 to 109 hours. At the end of this time they were in a state of extreme exhaustion and seemed semi-conscious. If the wakefulness had been further prolonged, this state of semi-con-

sciousness would have steadily changed until it culminated in the permanent unconsciousness of death. An examination of the brain cells of these animals showed physical changes identical with those produced by exhaustion from other causes, such as prolonged physical exertion or emotional strain. After 100 hours of wakefulness the rabbits were allowed a long period of sleep. All the brain cells were restored except those that had been in a state of complete exhaustion. A single seance of sleep served to restore some of the cells, but those which had undergone extreme changes required very prolonged rest. These experiments give us a definite physical basis for explaining the cost to the body mechanism of maintaining the conscious state. We have stated that the brain cell changes produced by prolonged consciousness are identical with those produced by physical exertion and by emotional strain. Rest, then, and especially sleep, is needed to restore the physical state of the brain cells which have been impaired, and as the brain cells constitute the central battery of the body mechanism, their restoration is essential for the maintenance of normal vitality.

In ordinary parlance, by consciousness we mean the activity of that part of the brain in which associative memory resides, but while associative memory is suspended the activities of the brain as a whole are by no means suspended; the respiratory and circulatory centers are active, as are those centers which maintain muscular tone. This is shown by the muscular response to external stimuli made by the normal person in sleep; by the occasional activation of motor patterns which may break through into consciousness causing dreams; and finally by the responses of the motor mechanism made to the injuring stimuli of an operation on a patient under inhalation anesthesia only.

Direct proof of the mechanistic action of many of life's phenomena is lacking, but the proof is definite and final of the part that the brain cells play in maintaining consciousness; of the fact that the degree of consciousness and mental efficiency depends upon the physical state of the brain cells; and finally that efficiency may be restored by sleep, provided that exhaustion of the cells has not progressed too far. In this greatest phenomenon of life, then, the mechanistic theory is in harmony with the facts.

Perhaps no more convincing proof of our thesis that the body is a mechanism developed and adapted to its purposes by environment can be secured than by a study of that most constant manifestation of consciousness—pain.

Like the other phenomena of life, pain was undoubtedly evolved for a particular purpose—surely for the good of the individual. Like fear and worry, it frequently is injurious. What then may be its purpose?

We postulate that pain is a result of contact ceptor stimulation for the purpose of securing protective muscular activity. This postulate applies to all kinds of pain, whatever their cause—whether physical injury, pyogenic infection, the obstruction of hollow viscera, childbirth, etc.

All forms of pain are associated with muscular action, and as in every other stimulation of the ceptors, each kind of pain is specific to the causative stimuli. The child puts his hand in the fire; physical injury pain results and the appropriate muscular response is elicited. If pressure is prolonged on some parts of the body, anemia of the parts may result, with a corresponding discomfort or pain, requiring muscular action for relief. When the rays

of the sun strike directly upon the retina, light pain causes an immediate protective action; so too in the evacuation of the intestine and the urinary bladder as normal acts, and in overcoming obstruction of these tracts, discomfort or pain compel the required muscular actions. This view of pain as a stimulation to motor action explains why only certain types of infection are associated with pain; namely, those types in which the infection may be spread by muscular action or those in which the fixation of parts by continued muscular rigidity is an advantage. As a further remarkable proof of the marvelous adaptation of the body mechanism to meet varying environmental conditions, we find that just as nociceptors have been implanted in those parts of the body only which have been subject to nocuous contacts, so a type of infection which causes muscular action in one part of the body may cause none when it attacks another.

This postulate gives us the key to the pain-muscular phenomena of peritonitis, pleurisy, cystitis, cholecystitis, etc., as well as to the pain-muscular phenomena in obstructions of the hollow viscera. If pain is a part of a muscular response and occurs only as a result of contact ceptor stimulation by physical injury, infection, anemia, or obstruction, we may well inquire which part of the nerve mechanism is the site of the phenomenon of pain. Is it the nerve ending, the nerve trunk, or the brain? That is, is pain associated with the physical contact with the nerve ending, or with the physical act of transmission along the nerve trunk, or with the change of brain cell substance by means of which the motor-producing energy is released?

We postulate that the pain is associated with the discharge of energy from the brain cells. If this is true, then if every nociceptor in the body were equally stimulated in such a manner that all the stimuli should reach the brain cells simultaneously, then the cells would find themselves in equilibrium and no motor act would be performed. But if all the pain nerve ceptors but one were equally stimulated, and this one more strongly stimulated than the rest, then this one would gain possession of the final common path—would cause a muscular action and the sensation of pain.

It is well known that when a greater pain or stimulus is thrown into competition with a lesser one, the lesser is submerged. Of this fact the schoolboy makes use when he initiates the novice into the mystery of the painless pulling of hair. The simultaneous but severe application of the boot to the blindfolded victim takes complete but exclusive possession of the final common path and the hair is painlessly plucked as a result of the triumph of the boot stimulus over the pull on the hair in the struggle for the final common path.

Persons who have survived a sudden, complete exposure to superheated steam, or whose bodies have been enwrapped in flame, testify that they have felt no pain. As this absence of pain may be due to the fact that the emotion of fear gained the final common path, to the exclusion of all other stimuli, we are trying by experimentation to discover the effects of simultaneous painful stimulation of all parts of the body. The data already in hand, and the experiments now in progress, in which anesthetized animals are subjected to powerful stimuli applied to certain parts of the body only, or simultaneously to all parts of the body, lead us to believe that in the former case the brain cells become stimulated or hyperchromatic, while in the latter case no brain cell changes occur. We believe that our experiments will prove that an equal and simultaneous stimula-

tion of all parts of the body leaves the brain cells in a state of equilibrium. Our theory of pain will then be well sustained, not only by common observation, but by experimental proof, and so the mechanistic view will be found in complete harmony with another important reaction.

We have stated that when a number of contact stimuli act simultaneously, the strongest stimulus will gain possession of the final common path—the path of action. When, however, stimuli of the distance ceptors compete with stimuli of the contact ceptors, the contact-ceptor stimuli often secure the common path, not because they are stronger or more important, but because they are immediate and urgent. In many instances, however, the distance-ceptor stimuli are strong, have the advantage of a lowered threshold, and therefore compete successfully with the immediate and present stimuli of the contact ceptors. In such cases we have the interesting phenomenon of physical injury without resultant pain or muscular response. The distance ceptor stimuli which may thus triumph over even powerful contact-ceptor stimuli are those causing strong emotions —as great anger in fighting; great fear in a battle; intense sexual excitement. Dr. Livingstone has testified to his complete unconsciousness to pain during his struggle with a lion; although he was torn by teeth and claws, his fear overcame all other impressions. By frequently repeated stimulation the Dervish secures a low threshold to the emotions caused by the thought of God or the devil and his emotional excitement is increased by the presence of others under the same stimulation; emotion, therefore, secures the final common path and he is unconscious of pain when he lashes, cuts and bruises his body. The phenomena of hysteria may be explained on this basis, as may the unconsciousness of passing events in a person in the midst of a great and overwhelming grief. By constant practise the student may secure the final common path for such impressions as are derived from the stimuli offered by the subject of his study, and so he will be oblivious of his surroundings. Concentration is but another name for a final common path secured by the repetition and summation of certain stimuli.

If our premises are sustained then we can recognize in man no will, no ego, no possibility for spontaneous action, for every action must be a response to the stimuli of contact or distance ceptors, or to their recall through associative memory. Memory is awakened by symbols which represent any of the objects or forces associated with the act recalled. Spoken and written words, pictures, sounds, may stimulate the brain patterns formed by previous stimulation of the distance ceptors; while touch, pain, temperature, pressure, may recall previous contact-ceptor stimuli. Memory depends in part upon the adequacy of the symbol, and in part upon the state of the threshold. If one has ever been attacked by a snake, the threshold to any symbol which could recall that attack would be low; the later recall of anything associated with the bite or its results would produce in memory a recapitulation of the whole scene, while even harmless snakes would thereafter be greeted with a shudder. On the other hand, in a child the threshold is low to the desire for the possession of any new and strange object; in a child, therefore, to whom a snake is merely an unusual and fascinating object, there is aroused only curiosity and the desire for the possession of a new plaything.

If we are to attribute to man the possession of a governing attribute, not possessed by other parts of the animal creation,

where are we to draw the boundary line, and say "here the ego—the will—the reason—emerges"? What attribute, after all, has man which in its ultimate analysis is not possessed by the lowest animals or by the vegetable creation, even? From the amœba, on through all the stages of animal existence, every action is but a response to adequate stimulus; and as a result of adequate stimuli each step has been taken toward the higher and more intricate mechanisms which play the higher and more intricate parts in the great scheme of nature.

The Venus fly trap responds to as delicate a stimulus as do any of the contact ceptors of animals, and the motor activity resulting from the stimulus is as complex. To an insect-like touch the plant responds; to a rough contact there is no response; that is, the motor mechanism of the plant has become attuned to only such stimuli as simulate the contact of those insects which form its diet. It catches flies, eats and digests them, and ejects the refuse. The amœba does no less. The frog does no more, excepting that in its place in creation a few more reactions are required for its sustenance and for the propagation of its species. Man does no more, excepting that in man's manifold relations there are innumerable stimuli, for meeting which adequately, innumerable mechanisms have been evolved. The motor mechanism of the fly trap is perfectly adapted to its purpose. The motor mechanism of man is adapted to its manifold uses, and as new environmental influences surround him, we must believe that new adaptations of the mechanism will be evolved to meet the new conditions.

Is not this conception of man's activities infinitely more wonderful, and infinitely more comprehensible than is the conception that his activities may be accounted for by the existence of an unknown, unimaginable, and intangible force called "mind" or "soul"?

We have already shown how the nerve mechanism is so well adapted to the innumerable stimuli of environment that it can accurately transmit and distinguish between the infinite variations of speed in the ether waves producing light, and the air waves producing sound. Each rate of vibration energizes only the mechanism which has been attuned to it. With marvelous accuracy the light and sound waves gain access to the nerve tissue and are finally interpreted in terms of motor responses, each by the brain pattern attuned to that particular speed and intensity. So stimuli and resultant actions multiplied by the total number of the motor patterns in the brain of man give us the sum total of his life's activities—they constitute his life.

As in evolutionary history the permanence of an adaptation of the body mechanism depends upon its value in the preservation of the life of the individual and upon its power to increase the value of the individual to the race, so the importance and truth of these postulates and theories may well be judged on the same basis.

The fundamental instincts of all living matter are self-preservation, and the propagation of the species. The instinct for self-preservation causes a plant to turn away from cold and damaging winds toward the life-giving sun; the inert mussel to withdraw within its shell; the insect to take flight; the animal to fight or to flee; and man to procure food that he may oppose starvation, to shelter himself and to provide clothes that he may avoid the dangers of excessive cold and heat, to combat death from disease by seeking medical aid, to avoid destruction by man or brute by fight or by flight. The instinct to propagate the species leads brute man by crude

methods, and cultured man by methods more refined, to put out of his way sex rivals so that his own life may be continued through offspring. The life of the species is further assured by the protective action exercised over the young by the adults of the species. As soon as the youngest offspring is able successfully to carry on his own struggle with environment there is no longer need for the parent, and the parent enters therefore the stage of disintegration. The average length of life in any species is the sum of the years of immaturity, plus the years of female fertility, plus the adolescent years of the offspring.

The stimuli resulting from these two dominant instincts are now so overpowering as compared with all other environmental stimuli that the mere possession of adequate knowledge of the damaging effects of certain actions as compared with the saving effects of others will (other things being equal) lead the individual to choose the right,—the self- and species-preservative course of action, instead of the wrong,—the self- and species-destructive course of action.

The dissemination of the knowledge of the far-reaching deleterious effects of protracted emotional strain, of overwork, and of worry will automatically raise man's threshold to the damaging activating stimuli causing the strong emotions, and will cause him to avoid dangerous strains of every kind. The individual thus protected will therefore rise to a plane of poise and efficiency far above that of his uncontrolled fellows, and by so much will his efficiency, health and happiness be augmented.

A full acceptance of this theory can not fail to produce in those in whose charge rests the welfare of the young, an overwhelming desire to surround children with those environmental stimuli only which will tend to their highest ultimate welfare.

Such is the stimulating force of tradition that many who have been educated under the tenets of traditional beliefs will oppose these hypotheses—even violently, it may be. So they have opposed them; so they opposed Darwin; so they have opposed all new and apparently revolutionary doctrines. Yet these persons themselves are by their very actions proving the efficiency of the vital principles which we have enunciated. What is the whole social welfare movement but a recognition on the part of municipalities, educational boards, and religious organizations of the fact that the future welfare of the race depends upon the administration to the young of forceful uplifting environmental stimuli.

There are now, as there were in Darwin's day, many who feel that man is degraded from his high estate by the conception that he is not a reasoning, willing being, the result of a special creation. But one may wonder indeed what conception of the origin of man can be more wonderful or more inspiring than the belief that he has been slowly evolved through the ages, and that all creatures have had a part in his development; that each form of life has contributed and is contributing still to his present welfare and to his future advancement.

RECAPITULATION

Psychology—the science of the human soul and its relations—under the mechanistic theory of life, must receive a new definition. It becomes a science of man's activities as determined by the environmental stimuli of his phylogeny and of his ontogeny.

On this basis we postulate that throughout the history of the race nothing has been lost, but that every experience of the race and of the individual has been retained for the guidance of the individual and of the race; that for the accomplishment of this

end, there has been evolved through the ages a nerve mechanism of such infinite delicacy and precision that in some unknown manner it can register permanently within itself every impression received in the phylogenetic and ontogenetic experience of the individual; that each of these nerve mechanisms or brain patterns has its own connection with the external world, and that each is attuned to receive impressions of but one kind, as in the apparatus of wireless telegraphy each instrument can receive and interpret waves of a certain rate of intensity only; that thought, will, ego, personality, perception, imagination, reason, emotion, choice, memory, are to be interpreted in terms of these brain patterns; that these so-called phenomena of human life depend upon the stimuli which can secure the final common path, this in turn having been determined by the frequency and the strength of the environmental stimuli of the past and of the present.

Finally, as for life's origin and life's ultimate end, we are content to say that they are unknown, perhaps unknowable. We know only that living matter, like lifeless matter, has its own place in the cosmic processes; that the gigantic forces which operated to produce a world upon which life could exist, as a logical sequence, when the time was ripe, evolved life; and finally that these cosmic forces are still active, though none can tell what worlds and what races may be the result of their coming activities.

G. W. CRILE
WESTERN RESERVE MEDICAL SCHOOL,
CLEVELAND, OHIO

THE CHESTNUT-BLIGHT PARASITE (ENDOTHIA PARASITICA) FROM CHINA

IN common with Dr. Metcalf[1] and some other pathologists the writers have believed in the foreign origin of the chestnut-blight and its causal organism.

Having first proved by thorough investigation[2] that the species of *Endothia* (*E. radicalis* (Schw.) De Not.) common on the chestnut in southern Europe is not an active parasite and is morphologically distinct from *E. parasitica* our attention was again turned to the orient. Previous efforts to get *Endothia* by correspondence from China and Japan have been fruitless.

Knowing Mr. Meyer's keenness of observation and facilities for examining chestnuts in China, it occurred to us to try to enlist his services in the search for the fungus. We took up the matter with Mr. Fairchild early in February, 1913. He heartily approved of the proposition and data were prepared and sent to Mr. Meyer. On June 28, as Mr. Fairchild has related, a letter was received from Mr. Meyer enclosing a small specimen of diseased chestnut bark collected June 3, 1913, near San tun ying, Chili Province, China. This specimen showed the characteristic mycelial "fans" in the bark and a few pycnidia which agreed exactly in macroscopic and microscopic characters with *Endothia parasitica*. Meyer's description of the disease on these Chinese chestnut trees (whose specific determination is still under investigation) also agreed with the behavior of the disease on some oriental chestnut trees in this country.

Cultures on cornmeal were made June 30 from the mycelium and from pycnospores from Meyer's specimen. The cultures from mycelium did not grow, but three of the four cultures made from pycnospores developed normally and appeared pure. Cultures of *Endothia parasitica* from American material were also made at the same time on the same medium for comparison. The development of the Chinese fungus was in all cases indistinguishable from that of American origin. The amount of growth, the color and character of the mycelium, time of appearance, abundance and distribution of pycnidia were so similar that it was impossible to tell the cultures

[1] Bur. Plant Ind., U. S. Dept. Agr., Bull. 121, pt. 6, 1908; also *Trans. Mass. Hort. Soc.*, 1912, pt. 1, pp. 69–95.

[2] C. L. Shear, "*Endothia radicalis* (Schw.)," *Phytopathology*, 3: 61, February, 1913.

apart. Twelve subcultures made from the original flasks also behaved exactly like *E. parasitica*. Fifteen pycnospore streak cultures on potato agar from the Chinese material and the same number from American material were made July 10. The development in all these cultures was the same, giving the characteristic growth and colors of the parasite as recently described by the writers.[3] The only difference noted was that the distinctive orange color of the mycelium at the base of the cornmeal agar slants began to show one day earlier in some of the Chinese than in the American cultures. Cultures of the parasite of both Chinese and American origin were also made on sterile chestnut twigs and on upright tubes of cornmeal agar and oatmeal in flasks. In all cases the organism behaved in exactly the same manner and gave a typical growth of the chestnut-blight fungus.

July 7 fourteen inoculations of several sprouts of *Castanea dentata*, eight to ten centimeters in diameter, were made in the vicinity of Washington with mycelium from one of the original cultures from the Chinese specimen. Within one week all inoculations showed evidence of disease. At the end of nine days the sunken areas of bark about the points of inoculation extended in some cases 1 to 1.5 cm. Microscopic examination showed well-marked typical mycelial "fans" in the bark. At the end of two weeks all of the 14 inoculations were rapidly developing and showed diseased areas of sunken bark often extending 2 to 3 cm. from the line of inoculation. Many pycnidia were present, but no spore threads or horns had appeared. The characteristic mycelial "fans" were conspicuous in the bark. None of the five checks showed any signs of disease. At the last examination of the inoculations made August 11 all were developing rapidly. The largest canker was 6 cm. wide and 14 cm. long. Pycnidia of *Endothia parasitica* with extruding spore masses were abundant. Pycnospores from these cankers appear identical in shape and general appearance with those from the original Chinese specimen and also with those from American specimens. The measurements of the pycnospores are as follows:

From an American specimen:

Maximum length	6.15	microns.
Minimum length	3.42	microns.
Average length	4.69	microns.
Maximum width	2.3	microns.
Minimum width	1.84	microns.
Average width	2.09	microns.

From Meyer's Chinese specimen:

Maximum length	5.84	microns.
Minimum length	3.3	microns.
Average length	4.75	microns.
Maximum width	2.38	microns.
Minimum width	1.84	microns.
Average width	2.05	microns.

Specimens from inoculations with the Chinese fungus:

Maximum length	6.3	microns.
Minimum length	3.46	microns.
Average length	4.67	microns.
Maximum width	2.3	microns.
Minimum width	1.76	microns.
Average width	2.04	microns.

Meyer's first specimen showed no perithecia. On July 23 more Chinese specimens were received from the same locality. These included a large typical canker on a chestnut branch about 6 cm. in diameter which agreed in every respect with cankers produced on varieties of Japanese chestnuts in this country. Other specimens in this collection showed well-developed perithecia and ascospores. Measurements of 100 ascospores from the Chinese specimen gave a

Maximum length of	11.1	microns.
Minimum length of	6.9	microns.
Average length of	8.4	microns.
Maximum width of	5.3	microns.
Minimum width of	3.5	microns.
Average width of	4.39	microns.

The same number of measurements from a typical American specimen gave a

Maximum length of	10.8	microns.
Minimum length of	6.9	microns.
Average length of	8.49	microns.
Maximum width of	5.1	microns.
Minimum width of	3.6	microns.
Average width of	4.32	microns.

[3] "Cultural Characters of the Chestnut-Blight Fungus and its near Relatives," Circ. No. 131, B. P. I., Dept. Agr., July 5, 1913.

The uniformity and constancy of both the physiological and morphological characters of this fungus are quite remarkable and striking.

The Chinese organism has thus been shown to be practically identical with the American in all its morphological and physiological characters and in the production of the typical chestnut-blight and the pycnidial fructifications of the fungus. There is apparently but one other requirement that could be made according to the strictest pathological canons to perfect the proof in this case, and that is the production of typical ascospores of *E. parasitica* on the lesions produced by the inoculations. These could scarcely be expected to appear for some weeks yet. The evidence, however, appears to us sufficiently complete to allow no escape from the conclusion that *Endothia parasitica* occurs in China and in such a locality and under such conditions as would indicate that it is indigenous there.

Just as this note was finished, Mr. Fairchild received a package of photographs of blighted chestnut trees from Mr. Meyer, taken in the same locality from which the specimens were obtained. These will be published later. Suffice it to add here that the illustrations show clearly by the evident age of the trees and of the infections that this Chinese chestnut is much more resistant to the disease than the American and that there is much hope for the successful selection and breeding of resistant plants.

C. L. SHEAR
NEIL E. STEVENS
BUREAU OF PLANT INDUSTRY,
August 16, 1913

THE DISCOVERY OF THE CHESTNUT BARK DISEASE IN CHINA

MR. FRANK N. MEYER, agricultural explorer of the Office of Foreign Seed and Plant Introduction of the Department of Agriculture, during his first exploring trip in northern China, 1905–1908, visited the Pang shan region east of Peking. He reported upon the existence of considerable quantities of wild chestnuts there, where they "grow wild on the slopes of rocky mountains. . . . It is mostly found in groves, growing among rocks and bowlders, and even in its wild state it varies considerably in the size and flavor of its nuts and the spininess of the burrs. The Chinese name for the wild form is San li tze,"[1] otherwise spelled Shan-li-tze. At the time of Mr. Meyer's exploration in the Pang shan region, there was comparatively little interest in this country in the chestnut bark disease, and not being a plant pathologist, he did not look for the disease among the chestnut trees from which he gathered chestnuts for introduction into this country.

When it was announced that Mr. Meyer would make a second expedition to north China, the question was raised by Drs. Metcalf and Shear, of the Office of Forest Pathology, as to whether or not Meyer might be requested to search for the disease among these Chinese chestnuts. On February 26, 1913, therefore, at Dr. Shear's request, Mr. Meyer was asked to make a search for the disease, and in order to inform him specifically as to what to look for, specimens of the diseased bark were sent him.

On June 13, 1913, the American legation cabled the state department as follows: "Meyer requests the legation to report that he has discovered chestnut bark fungus. Seems identical with American form."

On June 28 a letter was received from Mr. Meyer, written June 4 from a Chinese inn in an old dilapidated town to the northeast of Peking, between Tsun hua tcho and Yehol. In it Mr. Meyer announces the sending of a small fragment of diseased chestnut bark.[2]

[1] Meyer, Frank N., "Agricultural Explorations in the Fruit and Nut Orchards of China," Bulletin No. 204, Bureau of Plant Industry, p. 52, March 25, 1911.

[2] SAN TUN YING, CHILI PROV., CHINA,
June 4, 1913.

MR. DAVID FAIRCHILD,
Agricultural Explorer in Charge,
U. S. Department of Agriculture,
Washington, D. C., U. S. A.

Dear Mr. Fairchild: Here I am sitting in a Chinese inn in an old dilapidated town to the northeast of Peking, between ***Tsun hua tcho*** and

A subsequent shipment of the diseased material, consisting of bark and diseased branches of the tree, a few mature burrs, and nuts, was received July 23, 1913, and on August 11 a number of convincing photographs of the diseased chestnut tree. Full botanical material

Yehol and have been busy for several days collecting specimens of this bad chestnut bark disease and taking photos of same. It seems that this Chinese fungus is apparently the same as the one that kills off the chestnut trees in northeast America. I hope to send a cablegram through the American legation at Peking about this discovery to the Secretary of Agriculture. I am also enclosing a small piece of bark with this fungus on it. More material I hope to send off from Tientsin and Peking. Here are my main observations:

This blight does not by far do as much damage to Chinese chestnut trees as to the American ones.

Not a single tree could be found which had been killed entirely by this disease, although there might have been such trees which had been removed by the ever active and economic Chinese farmers.

Dead limbs, however, were often seen and many a saw wound showed where limbs had been removed.

Young trees and trees on level, poor soil were much more severely attacked than old trees or trees growing on richer, sloping soil at the base of rocks and hills. . . . The wounds on the bigger majority of the trees were in the process of healing over.

The Chinese farmers ascribe this disease to the working of caterpillars, grubs and ants, which are very freely found beneath the bark on these diseased spots on the main trunks and branches.

To combat the disease they scrape the bark clean every winter or early spring. The strips of bark are all collected, tied up in bundles and sold as fuel.

This Chinese chestnut does not grow to such sizes as the American one. Trees over 40 feet are rare. They are of low-branching habits with open heads, more or less in the way of the European chestnut (*Castanea vesca*).

The lumber is hard, but even a good-sized tree produces relatively little good lumber.

Old wounds are to be observed here and there on ancient trees.

The maximum age of this Chinese chestnut as seen in its native habitat seems to be between 250 and 300 years, but when that old they are already in decay.

The tree is not a fast grower and does not begin to bear until 12 to 15 years old.

The soil best suited to these chestnuts is a warm, well decomposed granite, with perfect drainage, while as locality they love the lower slopes of hills and mountains, where they are well sheltered.

The valleys and ravines in the lower altitudes of the Rocky Mountain regions would probably supply congenial localities for these chestnuts.

This northern Chinese chestnut is not a lumber tree, but attempts might be made to cross it with the American species, trying to give the last one more hardiness and resistancy against disease.

The nuts of this Chinese chestnut are not as large as those from the European and Japanese forms, but they are very sweet and are in great demand in China.

The great chestnut district of north China lies in the mountain valleys between the town of San tun ying and the Great Chinese Wall, 4 to 5 days' journey by carts from Peking to the northeast or 1½ to 2 days' journey by carts from the railroad station Tang shan on the railroad from Tientsin to Shan hai kwan. Most of the trees seen seem to be original growth, but also plantations have been made at the foot of the mountains and hills. . . .

for identification of this particular species which Mr. Meyer has been asked to get has not yet arrived, and the burrs do not agree with the description of *Castanea mollissima* Blume. This species according to the identification of the Arnold Arboretum authorities was collected by Mr. Meyer in the Pang shan region in 1907, and is now growing in this country under our S. P. I. number 21875. The region where Mr. Meyer discovered the disease is very close to the locality in the Pang shan region where he collected the nuts of *Castanea mollissima* in 1907, but it is impossible at this writing to determine with certainty the identity of this partially resistant Chinese species from San tun ying. This whole question will be discussed in a subsequent paper.

Those better qualified, Messrs. Shear and Stevens, are describing in this same number of Science the various steps taken by them in corroborating Meyer's discovery of the presence of the disease in China. It is interesting

to note, however, that only forty-two days elapsed from the time Meyer cabled, June 13, until every link in the chain of evidence of the identity of the Chinese with the American disease was complete. This included the discovery of the characteristic "mycelial fans," the making of cultures which appeared identical, the producing of the disease in American chestnut trees by inoculation from the cultures, and the discovery on July 24 of the ascospores of the fungus, *Endothia parasitica* (Murr.), on material later sent in. When we consider that the little town in the Chili province of China is a day and a half cart journey from a railroad, it is interesting to note the promptness with which exact laboratory research methods in Washington can be brought to bear on a field problem half way round the globe.

DAVID FAIRCHILD
U. S. DEPARTMENT OF AGRICULTURE

SCIENTIFIC NOTES AND NEWS

THE committee of the permanent commission for the International Congress of Medicine to be held in Munich in 1917 has been elected as follows: President, Professor Dr. Friedrich von Müller, of Munich (president-elect for the eighteenth congress); vice-presidents, M. Calman Müller, of Budapest (president of the sixteenth congress), and Sir Thomas Barlow, of London (president of the seventeenth congress); secretary-general, M. H. Burger, of Amsterdam; assistant secretary, D. Ph. van der Haer, of The Hague; member, M. L. Dejace, of Liège (president of the International Association of the Medical Press).

DR. ROUX, director of the Pasteur Institute, has been appointed a grand officer of the Legion of Honor.

MR. ROBERT BRIDGES, newly appointed poet laureate in Great Britain, holds a degree in medicine from Oxford and for some years was a practising physician.

THE Paris Academy of Sciences has awarded its Valz prize to Professor A. Fowler, F.R.S., for his investigations on the spectrum of hydrogen and other contributions to astrophysics.

DRS. A. BACMEISTER and L. Küpferle, of Freiburg, have received $1,000 from the Robert Koch foundation for their studies on Röntgen therapy in tuberculosis.

DR. C. F. HODGE, professor of biology at Clark University, will have leave of absence next year and will conduct work in Oregon under the extension department of the university and the Oregon state game commission.

DR. HENRY FAIRFIELD OSBORN, president of the American Museum of Natural History, has been visiting the expeditions conducting paleontological explorations for the museum in the west.

DR. F. ROBERT HELMERT, the distinguished Berlin geodesist, celebrated his seventieth birthday on July 21.

PROFESSOR ARCHIBALD BARR is about to retire from the regius chair of civil engineering and mechanics at the University of Glasgow.

THE Michigan State Board of Health has offered the position of state sanitary engineer to Professor E. D. Rich, of the University of Michigan.

MR. JAMES A. BARR, who for the past year has been manager of the Bureau of Conventions and Societies of the Panama-Pacific International Exposition, has been appointed chief of the department of education. He will have general charge of the congresses and conventions as well as of the educational exhibits. Dr. Irwin Shepard, for twenty years secretary of the National Education Association, has been appointed national secretary of the Bureau of Conventions, in San Francisco. Up to this time 151 congresses and conventions have been scheduled for San Francisco or near-by cities in 1915. At the meeting of the National Education Association held in Salt Lake City in July, the directors recommended that the 1915 meeting be held in Oakland, just across the Bay from San Francisco and within an hour of the Exposition grounds. The directors also recommended that an International Congress on Education be held in Oakland in 1915, under the general direction of a commission of thirty-four educators, with

Commissioner P. P. Claxton as ex-officio chairman and Mr. D. W. Springer as ex-officio secretary.

The fourteenth course of Lane Medical Lectures will be delivered in Lane Hall, San Francisco, on the evenings of September 3, 4, 5, 8 and 9, by Professor Sir Edward Schäfer, professor of physiology, University of Edinburgh. The subjects are as follows:

September 3—On internal secretion in general.
September 4—On the thyro-parathyroid glands.
September 5—On the adrenal glandular apparatus.
September 8—On the pituitary body.
September 9—The influence of internal on other secretions.
Methods of Resuscitation. (To be delivered at Stanford University.)

Among the lectures at the University of Chicago were those by Professor Carl Schröter, of the University of Zurich, who gave on August 6 and 7 two illustrated lectures on "The Lake Dwellings and Lake Dwellers of Ancient Switzerland" and "The Alpine Flora of Switzerland." On August 20 Professor Stephen A. Forbes, of the University of Illinois, gave an illustrated lecture in Kent Theater on "Fish and Their Ecological Relations," and Professor William Morton Wheeler, of Harvard University, discussed in two lectures this week "The Habits of Ants."

Professor Mel T. Cook, of the New Jersey Agricultural Station, while a visitor at the Biological Laboratory, recently gave a lecture on insect galls.

The town of Sanseverino in Italy will hold a celebration in September in honor of the quadricentenary of Bartolomeo Eustachio, the anatomist. A marble tablet will be unveiled and there will be a medical congress.

Mr. C. Leslie Reynolds, superintendent of the National Botanical Gardens in Washington, with which he had been connected for forty years, has died at the age of fifty-five years.

Mr. Frederick G. Plummer, geographer of the United States Forest Service, died on August 18, aged sixty-nine years.

The death is announced of Mr. T. H. Russell, of Birmingham, the author of a work on mosses and liverworts.

Dr. Hermann Credner, professor of geology at Leipzig and director of the Saxony Geological Survey, has died at the age of seventy-two years.

Dr. von Vogel, who had performed an important service in the organization of the Bavarian military health service, has died at the age of seventy-nine years.

The U. S. Civil Service Commission announces an examination for entomological assistant in the Bureau of Entomology, Department of Agriculture, for service in the field, at $2,250. The duties of this position will be to conduct a special investigation of the means of control of malaria-transmitting mosquitoes. It is desired to secure the services of a person who is familiar with the methods of control and eradication of mosquitoes in tropical and subtropical countries. Familiarity with the appearance and details of chronic malaria will also be of value. Other civil service examinations are: for assistant in botanical laboratory work in the Bureau of Plant Industry, at a salary of $1,500; for electrometallurgist in the Bureau of Mines at a salary ranging from $1,800 to $3,000; and for publicity expert in the Office of Public Roads, at a salary of $8 per day when employed.

The International Geological Congress will hold its next meeting in Brussels in 1917.

The International Solar Union, at its meeting at Bonn on August 5, passed the following resolution:

That, in collecting material for a report, the chairman of a committee may employ the method proposed in Science, Vol. 37, page 795.

It will be remembered that Dr. E. C. Pickering, director of the Harvard College Observatory, there suggested a standard form of committee meetings by correspondence.

For the first time in the history of the British Association psychology will be represented as an independent subject at the

forthcoming Birmingham meeting. It appears as a subsection to Section I (Physiology), and among those who have agreed to present papers are: Professor R. M. Ogden on "Experimental Data on the Localization of Visual Images"; Mr. C. Fox, "The Conditions which arouse Mental Imagery in Thought"; Professor Dawes Hicks, "Is there a Process of Psychical Fusion"; Dr. W. G. Smith, "Contrast as a Factor in Psychological Explanation"; Dr. C. S. Myers, "Experiments on Sound Localization"; Professor C. Read, "The Conditions of Belief in Primitive Minds"; Mr. W. McDougall, "A Theory of Laughter"; Dr. Wildon Carr, "The Absurdity of Psycho-physical Parallelism"; Miss May Smith, "Two Forms of Memory and their Relation"; Miss E. M. Smith, "Note of Habit Formation in Guinea-pigs"; Dr. F. C. Shrubsall, "The Relative Fertility and Morbidity of Normal and Defective Stock"; Mr. J. H. Wimms, "A Comparative Investigation of Fatigue Tests"; Miss May Smith, "Some Experiments on Recovery from Fatigue"; Dr. G. Thomson, "Variations in the Spatial Threshold"; Mr. Shepherd Dawson, "A Simple Method of Demonstrating Weber's Law"; Miss S. S. Fairhurst, "Suggestion and Discipline in Spelling"; Dr. C. W. Valentine, "Color Perception and Preference of an Infant"; Dr. McIntyre, "Practise Improvement in Immediate Memory in School Children"; Dr. E. O. Lewis, "Analytic and Synthetic Processes in Learning"; Dr. McIntyre and Miss A. L. Rogers, "Application of the Binet Scale to Normal Children in Scotland"; Mr. R. C. Moore, "Tests of Reasoning and their Relation to Mental Ability"; Mr. W. H. Winch, "Some Additional Tests of Reasoning"; Mr. T. H. Pear, "Modern Experiments on Testimony"; Mr. S. Wyatt, "The Testimony of Normal and Defective Children"; Dr. W. Brown, "Psycho-analysis"; Mr. T. H. Pear, "The Analysis of Some Personal Dreams with Special Reference to Theories of Dream Interpretation", and Mr. C. Burt, "Mental Differences between the Sexes." Joint meetings have also been arranged with the Physiological and Educational sections.

THE forest entomologist of the New York State College of Forestry at Syracuse is making a thorough study of the forest insects of New York. He has found that many kinds of insects injurious to trees are more numerous and are doing greater damage this year than usual. This is especially true of such insects as the tent caterpillars, aphids or plant lice and scale insects. This serious damage by insects to both fruit and forest trees during the past summer is due largely to the very mild weather of last winter, which allowed a large number of insects to pass the cold season successfully and the long rainless periods of spring and early summer, which enabled the young insects to get a good start in their life work of destroying vegetation. A number of reports have come in at Syracuse of the dying of the native hickory in different parts of the state. In most cases this is due to the hickory bark beetle, which is a very small boring insect, living between the inner bark and the sap wood of the hickory. This beetle makes a burrow in which it lays its eggs and from this burrow, smaller burrows are made in all directions by the young larvæ. The hickory tree, from a commercial standpoint, is doomed in New York state, unless very active work is done to prevent the spread of the insect. This can be done only by cutting the infested tree down and disposing of it in such a way as to kill all of the insects under the bark.

UNIVERSITY AND EDUCATIONAL NEWS

HAMPTON INSTITUTE receives $20,000 by the will of the late Robert C. Ogden.

THE thirteenth legislative assembly of Montana passed an act which provides that after the first day of July, 1913, the State University at Missoula, the College of Agriculture and Mechanic Arts at Bozeman, the School of Mines at Butte and the Normal School at Dillon, shall constitute the University of Montana, the control and supervision of which shall be vested in the State Board of Education. The State Board of Education has power, on the recommendation of the executive board of any of the institutions, to grant diplomas and to confer degrees on the gradu-

ates of all departments of the university. All of the engineering courses maintained by the state, with the exception of the course in mining engineering in the School of Mines at Butte, will be concentrated in the college at Bozeman. Dean A. W. Richter was transferred to Bozeman and becomes dean of engineering. Assistant Professors Wm. R. Plew and Philip S. Biegler were also transferred and added to the faculties of civil and electrical engineering, respectively.

Dr. Andrew Howard Ryan, for three years past instructor in physiology and pharmacology in the University of Pittsburgh, has accepted the chair of physiology in the medical department of the University of Alabama. He succeeds Dr. John Van de Erve, who recently resigned to take the chair of physiology in Marquette University, Milwaukee. Other appointments in the University of Alabama are: Dr. Howard H. Bell, of the University of Pennsylvania, full time assistant in the department of pathology; Dr. Jesse P. Chapman, instructor in orthopedic surgery; Dr. Percy J. Howard, associate professor of surgery; Dr. E. S. Sledge, instructor in radiography, and Dr. Julius G. Henry, instructor in medicine.

Dr. Wade H. Brown, professor of pathology in the University of North Carolina, Chapel Hill, has resigned, to accept service with the Rockefeller Institute of Medical Research, New York City, and has been succeeded by Dr. James A. Bullitt, late of the University of Mississippi.

Dr. Albert Einstein, docent for mathematical physics at the Zurich Technological Institute, known for his contributions to the theory of relativity, has been called to Berlin to succeed the late Professor J. H. van't Hoff.

DISCUSSION AND CORRESPONDENCE

COLOR CORRELATION IN COWPEAS

Some facts developed in my genetic investigations with cowpeas (*Vigna* species) are of interest in connection with the remarks of Professor J. K. Shaw, on page 126, concerning color correlation in garden beans. There are some interesting similarities and also interesting differences in these correlations as I have found them in the cowpea and as Professor Shaw finds them in the bean. I have, in most of the cases considered below, determined the particular Mendelian factor concerned in the correlation.

All varieties of cowpeas having coffee-colored seeds and all varieties having white or cream-colored seeds have white flowers and are devoid of anthocyan in stems and leaves. The flower color, which is due to an anthocyan, and the anthocyan in stems and leaves are dependent on two Mendelian color factors, one of which, apparently an enzyme, is the general factor for color in the seed coat of the cowpea. The other is the special factor for black which, when added to a variety having coffee-colored seeds, converts the seed color to black.

I have found three independent Mendelian factors for "eye" in the cowpea which, singly and together, give five distinct types of "eye." One of these factors, which gives the type of "eye" which I have designated the narrow "eye," also has the effect of inhibiting the development of anthocyan in the flowers, though it permits its development in stems and leaves. That is, the variety having the narrow "eye" has white flowers but has the pinkish-red or purplish color in certain portions of the stems and leaves. We apparently have here certain Mendelian factors which act differently in different parts of the plant, and this seems to be responsible for the correlation of the characters here discussed.

Cowpeas having any part of the seed coat black have anthocyan in the stems and leaves, and unless the factor for narrow "eye" is present there is also anthocyan in the flowers. Cowpea varieties having coffee-colored seeds have no anthocyan in stems, leaves or flowers. Cowpeas having buff or red seed coats may or may not have anthocyan in the stems and leaves and in the flowers according as the special factor for black or the factor for narrow "eye" is present or absent.

W. J. Spillman

U. S. Department of Agriculture

VARIATIONS IN THE EARTH'S MAGNETIC FIELD

OBSERVATIONS made in a tent on the lake shore in Mackinac County, Mich., during the last month have fully verified the results and conclusions published in my paper entitled "Local Magnetic Storms."

Cloud shadows diminish the permeability of the space within them in precisely the same way that the earth's shadow does at night. The molecules of air are ionized by solar radiation. They are then little magnets, which tend to set along the lines of force of the earth's field, in such a way as to add their magnetic effect to that of the earth's field. When solar radiation is cut off, the air molecules begin to return to their normal condition. Wind gusts and falling rain drops assist in this operation. They decrease the permeability.

When an iron bar is placed within a coil of wire carrying a current, its molecules are not quite so free to set in positions such that their magnetic effect is added to that of the coil. A blow from a wooden mallet then assists them. Its effect is directly the opposite of that produced by a gust of wind in air.

These results appear to furnish a rational explanation of the conditions which bring about local, daily and annual variations in the earth's magnetic field. Local variations are due to local variations in the weather. Clouds and sunshine, wind storms and rain, are the agents which bring about a continual swaying of the lines of force.

They also indicate an explanation of what causes the difference in permeability of solid matter.

In this work the needle was enclosed in an airtight case, and mounted on a silk fiber about 40 cm. in length. Its motion was damped. It was deflected at right angles to the magnetic meridian by magnets whose axes were at an angle of 45° with the meridian. The resultant field was partly compensated by bar magnets 120 cm. in length. All magnets were sealed within heavy rubber tubing, mounted in U-shaped supports, and enclosed in ice. The supporting table was a frame made of 2×4 inch timber, bolted together with brass bolts, and the legs of the structure were set two feet into solid clay and gravel soil. The frame was securely braced.

FRANCIS E. NIPHER
HESSEL, MICH.,
July 26, 1913

EXCUSING CLASS ABSENCES IN COLLEGE

THERE is no general uniformity in the matter of handling class absences in college. In some institutions the individual teachers still excuse for all absences in the course for which the teacher is responsible. In an increasing number of institutions the excusing power is centralized in some one office and in a large number of cases some form of the cut system is used. In some cases the student is allowed as many absences a semester from a course as the course recites times per week, that is, three absences from a three-hour course, four from a four-hour course, etc. In general the number of class cuts allowed seems to run as a minimum about 15 a semester—the number of absences allowed a semester in all courses approximating the number of recitation periods per week.

In cases where this minimum *is* allowed it means that 5½ per cent, approximately, of the class-room periods may be omitted by any or all students without any account being given for the absences.

A system such as this seems almost an invitation to a student to avail himself of the number of cuts allowed and in a large number of cases is so regarded.

In Oberlin College all class absences are reported to the dean of men and the dean of women, respectively. Each student must give an account to the proper officer of *all* absences.

The results during the semester ending in February, 1913, were as follows in the case of the college men: the average number of absences for each freshman was 6.1, for each sophomore 7.9, for each junior 7.5, for each senior 7.3. This includes absences for *all* reasons, sickness, absence on athletic teams, glee clubs, etc., and counts absences from *all* classes, including physical training. The record of no student is included who left college for any reason before the end of the semester.

The total number of men and absences were as follows during the semester just closed:

	Men	Total Absences	Average Absences per Man
Freshmen.....	115	702	6.1
Sophomore....	81	662	7.9
Junior.....	83	623	7.5
Senior.....	79	580	7.3
	358	2,567	7.17

Of this total number of absences 431 were due to athletics. This includes not alone the absences of the members of teams, but also of students absent to attend games. This number amounts to 17 per cent. of all the absences, but is less than one half of one per cent. of the total number of class periods involved.

795 of the absences were due to sickness, or were so reported. These figures do not attempt to go back of the reasons given for failure to attend class. *At least* 795 absences were so accounted for. It is quite possible that the number should be larger and that the reason was not in every case noted in the record book. This number is 31 per cent. of the whole number of absences, and added to the 17 per cent. caused by athletics accounts for 48 per cent. of the whole number. Of the absences, 52 per cent., or an average of 3.7 per man, were accounted for by various other excuses.

In the practical handling of the excuses, upper-class men are excused without much question as to the quality of the excuse if the number of absences for the semester has not exceeded six to eight. If the number of hours per week for each man is estimated at 15, a normal amount, the total number of absences would amount to 2.6 per cent. of the class periods involved. Or, looking at it in another way, the average attendance of the men for the semester is 97.4 per cent.

The figures from which these percentages are derived are as follows:

$$\frac{\text{Men}}{358} \times \frac{\text{Classes per week}}{15} \times \frac{\text{Week per semester}}{18} = 96.660$$

Total number of absences = 2,567

Percentage of absences, 2.6 per cent.

If 15 cuts a semester is somewhere near the number usually allowed the following figures are of interest: of the 115 freshmen 103, or 90 per cent., had *less* than 15 absences; of the 81 sophomores 66, or 81 per cent., had *less* than 15 absences; of the 83 juniors 74, or 89 per cent., had *less* than 15 absences; of the 79 seniors 68, or 86 per cent., had *less* than 15 absences.

The writer submits these figures that they may be compared with the results in other institutions, especially those where some form of the cut system is in use. It is the feeling of the writer that the fact that *each* absence has to be accounted for acts as a deterrent in a large number of cases, when the student would easily absent himself under the cut system.

Each instructor is furnished with blanks and is asked to report the absences for each day. These blanks are deposited in boxes adjacent to the classroom and are collected and entered in the record by a clerk. The scheme to be effective must enlist the support and cooperation of all instructors. The instructors must, of course, attempt to see that all absences are reported. The figures given are for absences actually reported. It is recognized that, owing to human frailty, a certain number are not reported. That same lack exists in any system that has yet been devised. The percentage of absences not reported is, I believe, small. May we have figures from other institutions? The figures I have given here would seem to indicate that a smaller number of cuts might prove feasible in those institutions that use the cut system.

I doubt if we have any scientific basis for estimating the number of excuses that a man is normally entitled to receive during a semester. Perhaps some figures of this kind will give us a start toward such a basis.

E. A. Miller

Oberlin College

SCIENTIFIC BOOKS

The Infancy of Animals. By W. P. Pycraft. With 64 Plates on art paper and numerous Illustrations in the text. New York, Henry Holt and Company. 1913. Pp. xiv + 272.

It would be difficult to find a more fasci-

nating theme in the whole realm of zoology than "The Infancy of Animals," and we think that the author of the work under this head has succeeded admirably in a difficult task—that of presenting a generous measure of significant fact, with due regard to scientific accuracy, and in readable English. Students of the invertebrates might feel that he was hardly justified in saying that the "childhood" of animals was a subject which has been strangely neglected. Yet this criticism would apply to most of the higher animals, with which he is mainly concerned. Take from the shelf any standard work upon mammals or birds, and you will look in vain for any adequate accounts of the young in most of the species described. If one were to consult a large museum instead, with but few notable exceptions, this neglect of the juvenile period of life would be even more apparent.

The infantile, juvenile, or adolescent phases of animal life, whatever be the names by which we attempt to classify the post-embryonic phases of development, which lead to the adult state, are not only difficult to correlate with reference to the "accident" of birth, but they are often exceedingly difficult to study. In many cases, our meager information is due to want of opportunity, rather than to lack of effort. Students who have worked for months at the seashore in the vain endeavor to trace a difficult life history, or who have tramped unnumbered miles in search of a particular bird or beast, in order to study its young, certainly need no admonition on this score.

The early post-embryonic life of animals embraces a very large section of zoology and psychology, and is of equal importance for comparative anatomy and evolution. The reader will find anatomical and evolutionary problems freely discussed, but the psychology of behavior does not come within the aims of the present work. Of the fourteen chapters of text, all but two of which deal with vertebrates, the most noteworthy are the three devoted to birds (Young Birds in the Nursery, Coloration, and Young Birds and the Records of the Past, Chaps. V.–VII.), a field in which the author is well known by his excellent "History of Birds," and numerous special contributions. These, as well as the remaining sections, are filled with pertinent and interesting facts, drawn from a wide field, and are imbued with the spirit which, after learning how, is not satisfied until it knows why.

Of the many perplexing problems which the coloration of animals presents, the retention of stripes in the livery of the young and adult, or in that of the young alone, is of special interest to students of evolution. The author maintains the Darwinian thesis that this character of the young is reminiscent of an ancestral condition. The primitive striped pattern has often been allowed to persist in the early stages of life, because it was either a direct source of protection, or at least because it was not harmful. In other words the mantle of the forefather has been thrust upon the juvenile descendant to protect him, in the absence of its parents, and has often been left there when of no further use. This longitudinal striping, which is found in representatives of all the vertebrates, is not only more characteristic of the young than of the adult, but is more common in species which have retained the greatest number of primitive characters. In the course of growth the stripes tend to break up into spots, which may be retained, or disappear, when the animal becomes uniformly colored. The nestlings of the emu and cassowary, the most primitive of living birds, as the author shows, are more or less completely marked over the entire body with a series of light stripes, on a dark ground, but these marks disintegrate, giving way to an adult plumage of uniform tint. The same conditions are repeated in the unrelated grebes, and in other groups of birds where striped nestlings occur, these markings tend to break up into spots that may be retained or disappear. Similar phenomena occur in mammals. The leopard may be unable to change his spots, or the tiger his stripes, but the lion can, or has, for his cubs still bear the birth mark of an ancestral spotted state.

Admitting the power of selection, through variation and heredity, to effect such changes for the better protection of young and adult,

our difficulties of interpretation are not at an end. How, upon the same principles, shall we account for the rather startling exceptions which confront us at every turn—the zebra, for instance, "the noblest Roman of them all," so far as this kind of livery is concerned, in which not only the young, but both sexes, are striped all over. For untold ages, so far as we can judge, zebras have haunted the open, sun-scorched veldt of South and Southeast Africa, where their conspicuous coats, seen from afar, are the boldest advertisement possible to their numerous enemies; yet they managed to thrive, at least until the white man appeared upon the scene with a rifle, and no satisfactory solution of the meaning of their stripes has yet been offered. How then are we to account for an assumed striped ancestral livery in so many animals, whether young or adult? As Darwin remarked, since in the horse family both sexes are colored alike, there is no evidence of sexual selection here, and if stripes and spots originated as ornaments, how does it happen that so many animals in their present adult state have lost them?

The parental care and affection afforded to offspring, so strongly evinced in the mammal and bird, can be followed in all its various degrees of manifestation to invertebrates of very lowly estate. The author has recorded a number of remarkable instances in birds, wherein interpretation is difficult, and perhaps impossible without a much fuller knowledge of behavior in every direction than is now possessed.

Bats have been seen to capture prey, when loaded with their young, and many birds in times of stress are equally independent, not only transporting their young from place to place, but even transferring their eggs, though, excepting the gray cuckoo, well authenticated cases of egg-transport are extremely rare. The great northern diver or loon is an adept in thus dealing with its young, as is also the lesser grebe or dabchick, mentioned by the author. More remarkable still is the way in which woodcock will sometimes carry their nestlings to and fro, from nest to feeding grounds, holding them, as we are told, apparently between their legs, and possibly with the further aid of their long bill placed underneath for support.

The author raises a more vexed question in his descriptions of the diving and fishing habits of certain birds, and their methods of dealing with their prey, as to whether the young really receive direct and deliberate lessons from their parents in all these things. If we were to ask the preliminary question, whether animals that are directed so completely by instinct need a teacher of this sort, we should be obliged to answer plainly in the negative. In this respect, so far as we can see, the different species of birds stand very nearly at a level, and in every case instinct, perfected by practise, or corrected by individual experience, and often aided by imitation, seems amply sufficient to guide the majority aright in every important vital activity. "What flight is to the eagle," says the author, "diving is to the nestlings of the auk tribe, grebes, and divers. . . . In acquiring the art there can be no doubt but that the young are instructed by their parents. The adult razor-bill has been seen to take her nestling by the neck and dive with it, many times in succession; and as these excursions seem to be anything but pleasant at first, the young one often dives for a moment to dodge its zealous parent, thus effecting the end to be attained. Young grebes are certainly given lessons in diving, and also in catching fish" (p. 68). A description follows of what the author regards as a diving and fishing lesson given to a young grebe by its parent. Later he says: "Young birds of prey receive instruction first in the art of breaking up their food, and later in its capture," and Macpherson's interesting story of the golden eagle is quoted in confirmation of these ideas.

We are quite ready to believe that the remarkable behaviors of the species referred to in the preceding statements have been accurately reported, but we doubt if the interpretation, though apparently so obvious and natural, is really correct. Such interpretations do not fit, when we closely study be-

havior in other directions, and in other species of birds. They do not comport with the workings of instinct in the great avian class. Flight, diving, the capture of food and its treatment, all seem to be as certainly provided for in the inherited stock-in-trade, as either nest-building or song. Young gulls, up to the time they take to the water, beyond which I have never been able to watch them closely, certainly get no direct instruction in regard to their food, but plenty which is indirect, and from the time they desert the family preserve they feed abundantly on insects. The parent is not only *alma mater,* but the great quickener and director of inherited impulses in the young, while at the same time she is the most fascinating model for them to copy. Aside from bodily protection and other minor services, the lack of this parental factor is hardly appreciable in the incubator-reared chick, but is much more apparent in a hand-reared American robin or nestling of any other altricious species, where the transition between simply taking what drops from heaven, and going about to search for it, are more difficult to compass. The impulses are in any case natural, though they can not be forced. That there is a "school of the woods" we do not deny, but we regard it as an easy "school," in which the "teacher" has a natural gift to impart and the "pupil" an inherited tendency to receive.

It is gull-nature to dally with the food in the presence of the young, laying it on the ground and picking it up again, and even putting it back in the "pocket," if it is not quickly mastered, and it is gull chick-nature to follow every movement of the parent, putting head to the ground to get the food, when this is dropped. In such ways, perhaps, a useful lesson, in looking to the ground as an early source of food, is gradually instilled. But this is probably of small consequence, for most inexperienced birds peck instinctively at attractive objects, and all the more readily if these are in motion.

Young hawks, which we have taken from the nest before they were able to stand, and reared in cages, when first introduced to live prey, such as frogs, rats and pigeons, dealt with it in every case in the most uniform and precise manner, and this way was characteristic of their race. Before getting such food they will even seize chips and grass, and practise what we may call "play at catching frogs and mice." They will approach the chip cautiously, crouch, squeal, strike, seize, and spread over it as if it were really alive, inflicting blows upon it with the tearing, ripping-up motion, with which they would treat an actual frog or a piece of meat.

What then was such a bird as the grebe, referred to above, about, when unceremoniously ducking its youngsters? It might be that it was imparting a genuine lesson in diving, of the direct sort, that is, given with a motive, in recognition of its progeny's needs, but we have gone to this length to point out that this supposition does not exhaust all the possibilities. It might be that the parental instincts were on the wane, or that their sequence was disturbed, for many birds, of which the moor hen has been noted by Howard, instinctively drive off their young, as soon as they are able to shift for themselves, teasing, pecking, and harrying them unmercifully. It would be important to ascertain if the grebes ever display the same instinct. A wider knowledge of grebe-play, cleaning, and other instinctive procedure, might afford further suggestions.

We could refer to parallel and even more striking cases in illustration of the difficulties of interpretation. During courtship most birds perform antics of some sort, in the course of which they spread and move their wings and tail and erect their feathers, Since many, like the gay and lordly peacock, are richly decorated, what more obvious interpretation than that this spreading is a form of display, a showing off of all their finery, in order to charm the female. This, as is well known, was Darwin's interpretation, and formed the basis of his theory of sexual selection, or as it is now often called, preferential mating. But more recent and more exact studies upon the whole course of sexual behavior, of which I would cite particularly the illuminating work of

Howard on the British warblers, have shown that these spreading movements are typically reflex, and that they are common to many periods of excitement, so it is probable that they really have nothing to do with "charming" the female, in the sense in which this word is commonly understood. Even the dull cat-bird can be seen to spread before a prospective mate, and as Howard has shown, the presence of the female is not always necessary to excite such behavior during the mating period. Essentially the same movements are executed at the instance of sudden sounds, or of fear, not to speak of the spontaneous antics of the turkey gobbler, or even of the gaudy peacock, which, as Darwin acknowledged, will spread in the presence of poultry and swine.

In a chapter on Reptiles and their Progeny, the author refers to the ancient story of the viper "swallowing" her young in times of danger, with the remark that since this reptile is viviparous, many persons who had supposed that they had taken its young from the alimentary tract had really assisted at their birth. Whether there is any germ of truth at the root of this hoary belief, or whether it rightfully belongs among the vulgar errors to which Thomas Browne consigned it in the seventeenth century, we do not pretend to say, but the author's suggestion does not remove all the difficulties. Many American naturalists of repute have supported the contention that certain snakes do occasionally refuge their young in the throat or esophagus, and numerous American species, both venomous and non-venomous, are included in the list. It is a matter of some historical interest that the American Association for the Advancement of Science, which met at Portland, Maine, in 1873, held in one of its sections a sort of convention on snakes. G. Browne Goode, who afterwards became the head of the United States National Museum, led the discussion, and F. W. Putnam, secretary of the Association, Theodore Gill, and other prominent naturalists took part in it. Goode's paper, which was suggested by a still earlier one by Putnam, in the *American Naturalist* for 1869, and was published in full in the Annual Reports of the society, was an attempt to show that many snakes give temporary refuge to their young, much as certain fishes are known to carry about and protect their eggs in their mouths. He received the support of all these men, in addition to that of one hundred other witnesses whom he considered reliable, including Sidney J. Smith, noted for his accuracy as a marine zoologist, and Edward Palmer, of the Smithsonian Institution. So strongly was this "viperine" story supported that Dr. Gill, in summing up the evidence, declared it was "sufficient to set the matter for ever at rest." This will illustrate in still another direction the difficulties of interpretation in animal behavior, whether actual or visionary. If such competent witnesses and judges were deceived, it must be due to some other cause than that which the author of "The Infancy of Animals" has adduced. It may be that the young of many snakes—and this is an idea which we owe to a somewhat old but excellent work by Miss Hopley—respond instinctively to the calls of their parent by running towards her head and afterwards concealing themselves under her body. If young snakes were thought to be seen running into the mouth, it would require but little imagination to see them pop out again, the mind having already, perhaps, pictured such a scene in advance. Otherwise, so far as we can see, if we discredit all these accounts, we must continue to regard the snake as the fruitful cause of all moral obliquity.

The author's illustrations, particularly the photographs, are excellent, and add distinctively to the attraction of a valuable and interesting work.

Francis H. Herrick

Lausanne,
June 20, 1913

Explosives. A Synoptic and Critical Treatment of the Subject as gathered from Various Sources. By Dr. H. Brunswig. Translated and annotated by Charles E. Munroe, Ph.D., LL.D., and Alton L. Kibler, M.S., Ph.D.

The excuse for producing a new book in the

field of explosives is well given in the preface: to bring together more closely the science and practise of the subject; to establish a closer cooperation between the scientist and the technologist. In this the author has succeeded most remarkably well. The important modern explosives are carefully reviewed and arranged according to chemical and physical views now held. Theoretical and mathematical discussions have been omitted, which makes the book valuable to the technologist who as a rule has troubles enough without trying to keep in practise on advanced mathematics.

In chapter one there is given a clear outline of the elementary principles relating to the general behavior of explosives. Chapters two, three and four treat of velocity, temperature and pressure produced by explosives on combustion. An excellent discussion of the products of explosive reactions as influenced by temperature and pressure is given in chapter five. Chapter six treats of intensity and velocity of the explosive impulse. Chapter seven is of special importance to miners and ordnance officers since it treats of the flame of an explosion. Igniters, fuses, detonators and fulminates are described in chapter eight. In chapter nine there is a brief but excellent discussion of black and smokeless powders. Blasting explosives in chapter ten are fully discussed, including hints for handling, use and destruction of explosives generally.

A valuable feature of the book is the splendid list of references to literature on explosives and related subjects. The work, which on the whole is excellent, has lost nothing by translation. Works of this character are frequently ruined by translators, either on account of lack of knowledge of the foreign language or unfamiliarity of the subject. In this case the translators show a thorough knowledge of German, and surely Dr. Munroe is more familiar with explosives than any one else in this country. It is gratifying to note that attention is called to the fact that the term "nitroglycerine" is not in accordance with present-day chemical nomenclature. Why not discard also the name "nitrocellulose"? The latter is a nitrate just as much as the former. On page 161 in equati one there should be shown six carbon dioxids instead of two, and on page 162 where the decomposition of picric acid is shown six molecules, not two, of hydrogen are formed. Nothing further remains to be said except that no explosives library is up to date without this work.

A. P. SY

NOTES ON METEOROLOGY AND CLIMATOLOGY

THE SOLAR CONSTANT OF RADIATION

VOLUME III. of the Annals of the Astrophysical Observatory of the Smithsonian Institution has just appeared (a great quarto volume of 241 pages). As a result of recent investigations of the intensity of solar radiation, these noteworthy results have been obtained: (1) That the mean value of the solar constant of radiation for the epoch 1905–1912 is 1.929 calories per square centimeter per minute; (2) an increase in the solar constant by 0.07 calories per square centimeter per minute is accompanied by an increase of 100 in sun-spot numbers; (3) numerous, almost simultaneous measurements of the solar constant at Mount Wilson, California, and at Bassour, Algeria, would indicate that the intensity of solar radiation experiences an irregular change which frequently exceeds 0.07 calories per square centimeter per minute and which follows a ten-day period; (4) indications of two entirely independent phenomena makes it reasonable to believe that the variations in the solar constant are caused by the sun itself and probably not by meteoric dust or other phenomena between the sun and earth.[1]

WEST INDIA HURRICANES

IN a recent Weather Bureau bulletin entitled "Hurricanes of the West Indies,"[2] Professor Oliver L. Fassig gives the results of a thorough

[1] C. G. Abbot, F. E. Fowle and L. B. Aldrich, "Die Solarkonstante und ihre Schwankungen," *Meteorologische Zeitschrift*, pp. 257–261, June, 1913.

[2] Bulletin X., U. S. Weather Bureau, March 29, 1913, quarto, 28 pp., 25 plates.

investigation of 134 West India hurricanes occurring in the 36 years 1876–1911. The area visited by these storms includes the Gulf of Mexico, the Caribbean Sea and the tropical ocean for a few hundred miles east of the West Indies and Florida,—thus the routes leading to and from the Panama Canal on the Atlantic side will lie for a great distance in the heart of the hurricane zone. There are two main hurricane paths, one following the inside Gulf Stream route and the other the line of the northward Atlantic drift off the north and east coasts of the Greater Antilles and Florida. The former is most frequented by the cyclones in June and July and the latter in August, September and October. In these last three months 88 per cent. of the 134 cyclones occurred. Their tracks are normally parabolic, open to the east. The average rate of movement on the first branch (northwestward) and during the "recurve" (northward), is 11 miles per hour. On the second branch (moving northeast) the mean velocity increases to 16 miles per hour. The mean duration was 5.8 days (maximum 19, minimum 1 day). The number of West India hurricanes in the 20 years 1880–1899 was 86, as against 418 typhoons in the west Pacific and 184 cyclones in the Bay of Bengal during the same period. Professor Fassig considers West India hurricanes as mainly the result of general atmospheric movements and not of local differences in temperature. When in summer the equatorial belt of calms has moved some distance north of the equator, the deflective action of the earth's rotation is sufficient to produce a cyclone when an adequate initial impulse comes from the somewhat conflicting trade winds north and south of the doldrums.

HUMIDITY AND FROST DAMAGE

Professor A. G. McAdie in the *Monthly Weather Review* for April, 1913, in an article entitled "Frost Studies—Determining Probable Minimum Temperatures," points out that in frost damage to plants the relative humidity of the air is a very important factor. For instance, in the frost of January 4–7, 1913, in southern California the dryness of the air favored rapid radiation and evaporation, causing damage to plants not only on account of the low temperature but also through serious interference with proper plant functions, especially in connection with transpiration, which became injuriously rapid.

On another page of this number, Mr. E. S Nichols, local forecaster at Grand Junction, Colo., in connection with a damaging frost on April 23 also calls attention to the fact that on dry frosty nights greater injury is done than on moist ones with equal air temperatures. He has accordingly warned fruit-growers in his district to begin smudging on dry frosty nights at higher temperatures than on damp ones.[3]

CLOUDINESS AND SUNSHINE OF NORTH AMERICA

An important contribution to the climatology of North America entitled "Bewölkungsverhältnisse und Sonnenscheindauer von Nordamerika," by Arthur Gläser, has recently appeared.[4] The area covered is limited on the north on account of lack of observations to include only southern Canada. There are three general regions where the mean annual cloudiness is in excess of 60 per cent.—around Puget Sound, the Great Lakes and the Canadian Maritime Provinces. A minimum of less than 20 per cent. occurs in the region about the lower Colorado River in southwestern Arizona and southeastern California. This relative distribution in general remains the same throughout the year. Maximum cloudiness for southern and eastern United States and the Pacific coast including the Great Basin comes in winter; for the Great Plains, in spring; for New Mexico, Arizona, most of Mexico and Florida, in summer; and for the country roughly north of latitude 43 degrees and east of the one hundredth meridian, in November. Minimum cloudiness comes in winter over central Canada; in spring over most of Mexico

[3] See also E. A. Beals, "Forecasting Frost in the North Pacific States," Weather Bureau Bull. No. 41, 1912.

[4] Aus dem *Archiv der Deutschen Seewarte*, XXXV., 1912, Nr. 1, quarto, 63 pp., 22 figs., 7 charts.

and Florida; in summer throughout northern United States and the Great Basin; and in fall over the California coast, central Rockies, southern and eastern United States. The duration of sunshine is about the reverse of the cloudiness indicated, for the cloudiness records are practically only from observations in the daytime.

Previous cloudiness charts for the United States were published (1) in 1890 by General A. W. Greely, of the Signal Service; (2) in 1898 by the Weather Bureau;[5] (3) in 1911 by K. McR. Clark.[6]

AUSTRALIAN METEOROLOGY

THE Australian Weather Service has recently published new monthly and annual temperature and rainfall charts of Australia and Tasmania based on observation series from twenty to forty years in length. These charts correspond closely with earlier ones except that the annual isotherms sweep north in the center of Australia instead of south and the isohyts show the rainfall in greater detail. An annual rainfall of less than 5 inches is indicated in South Australia and as high as 140 inches on the Queensland coast. Commonwealth Meteorologist H. A. Hunt has invented a novel rotary diagram called a "rainfall clock," which indicates in a striking manner the progressive monthly changes of Australian rainfall.

The remarkable constancy and regularity of Australian weather has led Mr. Hunt to suggest the foundation of international meteorological observatories there for purposes of research in the fundamental problems of dynamic meteorology.[7]

NOTES

HOFRAT PROFESSOR DR. JULIUS VON HANN writes that a third edition of his great "Lehrbuch der Meteorologie" will soon begin to appear. It is coming out in sections to make its purchase easier. He expects the work to be complete in the fall of 1914. The first edition appeared in 1901 and the second in 1906. From 1908–1911 Dr. von Hann published the third edition of his great "Handbuch der Klimatologie" in three volumes. These two magnificent works are second to none in the realm of meteorology and climatology.

THE Royal Academy of Holland has conferred the Buys-Ballot Medal on Dr. H. Hergesell in recognition of his service in the investigations of the upper air in the subtropics and arctic, and as head of the International Commission for Scientific Aeronautics. In 1903 this medal was conferred on Professors Assmann and Berson, and in 1893 on Dr. von Hann.

DIRECTOR M. A. RYKATCHEW, of the Nicholas Central Physical Observatory, at St. Petersburg, retired on May 7, after having served 46 years, of which the last 17 were as director.

IN the report of the Chief of the Weather Bureau for 1911–12, recently issued, mention is made of preparations for proposed anemometer tests by Professor C. F. Marvin, now Chief. A whirling machine with an arm thirty feet long and capable of producing wind velocities up to 70 or 80 miles per hour will be used. There will be tests carried on also in a "wind tunnel" through which with blowers a current of air exceeding 100 miles per hour can be forced. These tests are for the purpose of correcting the standard Weather Bureau anemometers to record true wind velocities instead of some 18 per cent. too high as in the past and at present.

CHARLES F. BROOKS
BLUE HILL METEOROLOGICAL OBSERVATORY

[5] Report of the Chief of the Weather Bureau, 1896–97.

[6] *Quarterly Journal of the Royal Meteorological Society*, April, 1911, pp. 169–175.

[7] See *Nature*, London, Vol. 91, pp. 355, 435–436, 489.

SPECIAL ARTICLES

THE REDISCOVERY OF PERIDERMIUM PYRIFORME PECK

THE name *Peridermium pyriforme* was proposed by Peck in 1875 for a blister rust growing "on pine limbs in the spring, Newfield, New Jersey." In his original description Peck laid emphasis on the form of the spores which he described as "obovate, pyriform, or oblong-

pyriform, acuminate below, .0015–.0025 inch long." So far as published reports show, no specimen of *Peridermium* has been recorded since that time having spores of this sort. Among mycologists it generally has been assumed that there must have been some error about Peck's description, and the name has been made to apply to a species having the ordinary small ellipsoid spores. The species to which the name has been thus applied is the one which has been culturally connected with *Cronartium Comptoniæ*.

After giving some attention to the matter several years ago the writers came to the conclusion that in Peck's original examination he possibly mistook some of the smaller peridial cells for spores.[1] In studying fresh specimens recently communicated to us from British Columbia, by W. P. Fraser, and from Colorado, by E. Bethel, we have found large pyriform cells which agree exactly in shape and size with the spores of the original description of *Peridermium pyriforme*. It is very evident that in these specimens they can not be peridial cells, for the peridial tissue is present and is composed of very different cells. There seems to be little doubt that we are dealing here with a striking species, very aptly named *Peridermium pyriforme* so many years ago, but which has been unrecognized ever since, while the name has been misapplied. Examination of our herbarium shows that there are a number of other specimens belonging here which had been erroneously, and carelessly, placed under other species. In addition to the three above-mentioned localities we have specimens from Wisconsin, South Dakota, Washington and Alberta. The range for the species is thus seen to be northern United States and southern Canada from ocean to ocean.

Having established the existence of a characteristic heterœcious form of wide geographical range, the question of the alternate phase becomes of immediate interest. Judging from analogy and distribution, together with some field observations, we suggest with much confidence that *Peridermium pyriforme* may be connected with *Cronartium comandræ*.

[1] See *Bull. Torrey Bot. Club*, 33: 420, 1906.

J. C. Arthur
Frank D. Kern

Purdue University,
Lafayette, Ind.,
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A WINE-RED SUNFLOWER

In *Popular Science Monthly*, April, 1912, I described the finding and subsequent development of the red sunflower. The darker form predicted for 1912 duly appeared, but most of the intensely red types were bicolored, with the ends of the rays yellow. This is ascribed to the fact that the wild plant (var. *lenticularis*) carries a factor for marking, which is not clearly apparent until joined by the factor for red. In the orange or yellow rayed plants nothing more is apparent to the eye than a deepening of the color on the basal part, not distinctly defined or very readily noticeable. In photographs, however, the marking comes out, as is well shown in Dreer's "Garden Book," 1912, p. 221, for the perennial species. One would imagine from Dreer's figures of "Wolley Dod" and "multiflorus maximus" that the rays were bicolored. A much more striking illustration is given by Mr. G. N. Collins,[1] where *Bidens heterophylla* appears to have strongly bicolored rays when photographed in the ordinary way, but when photographed on an orthochromatic plate with a color screen does not appear bicolored at all. To the eye "the difference in color between the base and tip of the rays is barely perceptible."

We obtained from Sutton, of Reading, England, a variety of *Helianthus annuus* with very dark disc and pale primrose yellow rays. It is a tall, upright form, with the ends of the involucral bracts longer than usual. The seeds are black, or nearly. This plant, which comes quite true from seed, is called by Sutton, "Primrose Perfection"; we will call it var. *primulinus*.

In our red sunflowers so far obtained, the red, however bright, was always chestnut, as the result of the orange background. We saw

[1] *Plant World*, November, 1900, plate VII.

at once that if we could get the red (anthocyan) on the primrose background, we should have a quite new and more rosy color. In the summer of 1912 we accordingly crossed the reds with *primulinus,* and obtained a quantity of seed. The *primulinus* was used as the seed plant. As orange was sure to be dominant over primrose (or absence of orange), we could not expect to see our new variety until the F_2 generation. In order to hasten matters, we raised the F_1 generation indoors during the winter, and got enough seed to produce quite a series of plants. The F_1 plants did not differ in any respect from the reds to which we were accustomed, all having a rich orange-yellow background. Some, especially in the larger series now growing in the garden, show extremely rich and deep red colors, so that we should take them for homozygous reds if we did not know otherwise. On July 16 the first of the F_2 plants came into flower, and we were pleased to see that the rays had an entirely new shade of color, wine red on a primrose background. The first one, probably heterozygous for red, was rather dilutely colored, but we now have plants showing rays of a very rich deep wine red, with variable primrose tips. This new variety may be named *vinosus.* It is certainly interesting to obtain in this way an entirely new color, which nevertheless is due entirely to the redistribution of previously known factors, and which could thus be predicted in advance. Up to the time of writing, 21 F_2 plants have bloomed, of which 12 are red (of the chestnut type, of several minor varieties, as suffused and bicolored), 8 are *vinosus,* and one is pure primrose like the grandmaternal ancestor. This exactly agrees with the theoretical expectation as regards the reds and the primrose, but we have so far twice as many *vinosus* as expected, and no plain orange-yellows, of which there should be three or four. Probably when all the plants are in bloom the result will agree more exactly with the expectation.[2]

[2] *Postscript.* A census taken August 9 gives 71 red (chestnut), 19 yellow, 25 vinous and 8 primrose. The theoretical expectation for this number is 69 red, 23 yellow, 23 vinous and 8 primrose.

We have obtained a number of other varieties, which will be fully described at some other time. One curious one, which I call *tortuosus,* has the apical half of the rays twisted, as though in curl-papers. We have this both in the plain orange yellow and rich chestnut red with yellow tips, in each case the disc being dark. Similar forms have been obtained at other times by horticulturists.

A collection of seeds shows extraordinary variability in form and color; it would hardly be too much to say that the seeds are less alike than the resulting plants. Thus the tall primrose (*primulinus*) has black or nearly black seeds, Sutton's double primrose has gray seeds streaked with white, while there is a strain of dwarf primrose with perfectly white seeds. Seeds from any one plant are practically uniform, and we do not find any evidence that the pollen used affects the appearance of the resulting seed.

T. D. A. COCKERELL
UNIVERSITY OF COLORADO,
BOULDER, COL.,
July 22, 1913

SOCIETIES AND ACADEMIES

THE BIOLOGICAL SOCIETY OF WASHINGTON

THE 512th meeting of the Biological Society of Washington was held in the assembly hall of the Cosmos Club, April 19, 1913, with Vice-president Hay in the chair and about 30 persons present.

Under the heading "Brief Notes and Exhibition of Specimens," Henry Talbott exhibited an unusually large tooth of the fossil shark, *Carcharodon megelodon* from South Carolina and by way of comparison the much smaller teeth of *Odontaspes* from Chesapeake Beach, Md., and made remarks on these sharks.

Wells W. Cooke made remarks on the spring migration, noting that the yellowthroat, redstart, wood thrush and catbird had arrived three days ahead of schedule time.

The regular program consisted of a communication by C. D. Marsh, entitled "Stock Poisoning by Larkspur." He stated that ranchmen of the west had long claimed losses of stock due to larkspur, and on scientific inquiry had found their observations correct, and that the monetary loss was considerable. Although larkspur occurs in other parts of the world, it apparently only causes trouble in the western United States. The average

mortality in affected areas of the west is from 3 to 5 per cent., but as many as 20 head out of a herd of 200 have been fatally poisoned in twenty-four hours. The low larkspur appears to be always dangerous, but the tall only becomes poisonous in August after the fruit matures. The poison is a cumulative one and requires from 3 to 10 per cent. of the animal's body weight of larkspur plant to cause death or alarming symptoms. The symptoms consist of general discomfort, nausea, constipation, a characteristic arching of the back and sudden collapse, followed by partial recovery and a repetition of similar attacks, and if the case is a fatal one, to end in respiratory paralysis and death by asphyxia. Animals do not become immune to the poison. Horses may be experimentally poisoned, but when feeding on the range do not eat into a patch of larkspur enough to consume a toxic quantity. Sheep are naturally immune to the poison and may be fed a continuous diet of little else than larkspur without showing any symptoms. The cowboy's treatment of the disease is bleeding, but the proportion of recoveries by this method is not greater than in natural recovery. Rational treatment consists in placing the poisoned animal on sloping ground with the head upward so that the abdominal viscera fall back from the thoracic organs. Drug treatment consists of eserine, pilocarpine and strychnine administered hypodermically. Under this method 96 per cent. of poisoned animals recover. Alcohol is also effective, but less practical. The paper was profusely illustrated by excellent lantern slides, showing the larkspur in detail and on ranges, and numerous animals in various stages of poisoning. The paper was discussed by Messrs. Bailey, Weed, Hitchcock, Gill, Lyon and others.

The 513th regular meeting of the Biological Society of Washington was held in the assembly hall of the Cosmos Club May 3, 1913, at 8 P.M., with President Nelson in the chair and 56 persons present.

Under the heading "Brief Notes and Exhibition of Specimens," Dr. H. M. Smith called attention to a large whale shark captured during the past year in Florida waters. It originally measured 38 feet in length, but as now mounted, 45 feet; it is being exhibited as a curiosity. Pictures of this shark were exhibited and extracts from a letter by the captor read. Dr. Smith's remarks were discussed by the chair and by Dr. Gill.

The regular program consisted of two communications by Dr. C. Hart Merriam and one by Edmund Heller.

I. "The Remarkable Extinct Fauna of Southern California revealed in the Asphalt Deposits near Los Angeles." Dr. Merriam remarked that asphalt had been known in this region to the Indians for thousands of years and was mentioned by the early Spanish padres. Although remains of animals in the asphalt deposits had been known since about the middle of the last century they have only lately been extensively studied by Dr. J. C. Merriam, of the University of California. The viscous asphalt appears to have acted as a natural trap, first entangling certain birds and mammals, and then these captured animals acting as bait to larger predatory forms. The remains may be roughly divided into three groups: (1) birds, some still existing, but mostly extinct, among them, hawks, 8 genera of eagles, vultures, including both North and South American condors, a condor-like bird, *Teratornis* of huge size, owls, ravens, herons, a peacock; (2) small mammals, as spermophiles, kangaroo rats, etc., and small carnivorous forms as weasels, skunks, badgers, bobcats, gray foxes; (3) large mammals, as deer, antelopes, buffaloes, elephants, mastodons, glyptodons, and large predatory forms, as wolves, mountain lions, giant lions, saber-toothed tigers and bears. Often several individuals of carnivorous forms, as giant wolves, saber-toothed tigers are associated with a single large ruminant. Discussed by Messrs. Gill, Hay and others.

II. "Notes on the Big Bears of North America." The speaker commented on the lack of adequate material for a systematic study of these bears. The black bear and allied forms he regarded as constituting a distinct genus from the brown and grizzly bears belonging to the genus *Ursus*, about 40 forms of which could be recognized as inhabiting the North American continent and adjacent islands.

III. "Distribution of Game Animals in Africa." Mr. Heller spoke of the life zones and areas of East Africa, illustrating the subject with maps, views of topography and characteristic mammals. The following areas, based mainly upon watersheds, were recognized: West Nile, East Nile, Uganda, East African, Abyssinian; and these life zones: Congo Forest, Tropical, Nyika, Highland Veldt, Highland Forest.

M. W. Lyon, Jr.,
Recording Secretary pro tem.